Active Project (2014)

Lander Technology Project

Advanced Exploration Systems Program | Human Exploration And Operations Mission Directorate (HEOMD)

ABSTRACT

The Lander Technology project aims to develop a suite of lander spacecraft capabilities that enable human exploration beyond low Earth orbit. Propulsion, guidance, naviagtion and control (GNC), and other technologies are developed to reduce technical risks for future human and robotic landing missons to the Moon, Mars, and other solar system destinations.

ANTICIPATED BENEFITS

To NASA funded missions:

These technologies have potential application to the Mars 2020 mission. Guidance and navigation technologies for lander vehicles enable Terrain Relative Navigation (TRN) and high-precision landing on planetary surfaces and allow mission planners to target landing sites that are more interesting and likely to support the fulfillment of more significant science and exploration mission objectives.

To NASA unfunded & planned missions:

These technologies have potential application to Evolvable Mars Campaign missions including human and robotic missons to the Moon and Mars. The benefits include enabling the development of space propulsion systems that use non-toxic ("green") propellants, potentially producible from space resources. Liquid oxygen/methane (LOX/CH_4) engines feature high performance including high specific impulse (Isp), and are being produced using new, lower-cost additive manufacturing techniques (3-D printing). These qualities improve the operability, affordability, and sustainability of space systems.

DETAILED DESCRIPTION

Autonomous Landing and Hazard Avoidance Technology (ALHAT) capabilities have been functionally demonstrated on the Morpheus test bed. A Navigation Doppler Lidar (NDL) system is being matured and will be integrated with

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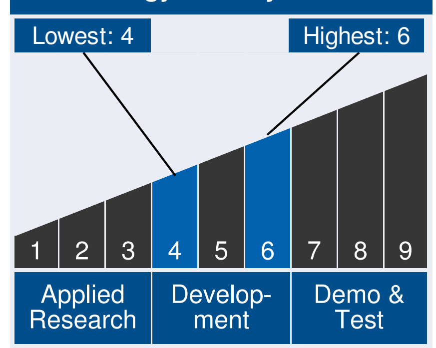
Technology Maturity



Management Team

Program Director:

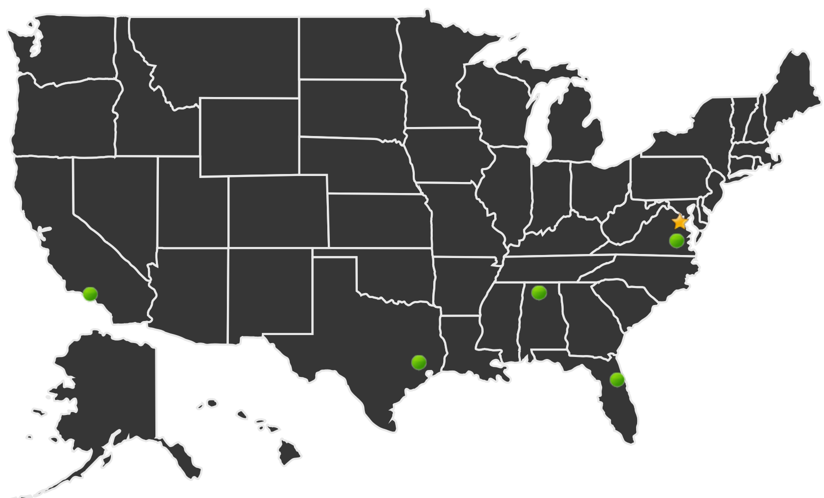
- Jason Crusan

Program Executive:

- Nantel Suzuki

complementary Terrain Relative Navigation (TRN) and precision landing sensors for FY16 flight testing on a terrestrial testbed. Hotfire testing is being performed on a 4500-lbf thrust regeneratively cooled LOX/CH_4 engine with additively-manufactured components.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
NASA Headquarters

Supporting Centers:

- Jet Propulsion Laboratory
- Johnson Space Center
- Kennedy Space Center
- Langley Research Center
- Marshall Space Flight Center

Contributing Partners:

- Masten Space Systems, Inc.

Management Team *(cont.)*

Project Manager:
- Greg Chavers

Technology Areas

- In-Space Propulsion Technologies (TA 2)
- Entry, Descent, and Landing Systems (TA 9)
- Advanced Guidance and Navigation Systems (TA 9.1.4.6)
- Descent and Targeting (TA 9.2)
- Advanced Algorithms and Sensors for Supersonic Retropropulsion (SRP) (TA 9.2.3.1)
- Advanced Sensors for Spacecraft Velocimetry and Altimetry (TA 9.2.7.1)
- Terrain/Map Absolute Localization (TA 9.2.8.1)
- Terrain/Terrain Relative Location (TA 9.2.8.2)
- Autonomous Hazard Detection and Avoidance (TA 9.2.8.4)

DETAILS FOR TECHNOLOGY 1

Technology Title

ALHAT capabilities including Navigation Doppler Lidar (NDL)

Technology Description

This technology is categorized as a hardware system for manned spaceflight

Autonomous Landing and Hazard Avoidance Technology (ALHAT) includes sensors such as laser altimeters, optical cameras, 3D Lidars, and a Navigation Doppler Lidar (NDL).

Capabilities Provided

This technology provides capabilties for Terrain Relative Navigation (TRN), in which real-time images and data of a planetary surface are captured and automatically compared with previously generated maps to determine a spacecraft's position. This technology also provides the capability to detect and avoid hazards on the surface (e.g., boulders and craters). Together, these capabilities enable safe and precise landing on planetary bodies.

Potential Applications

Human and robotic Moon and Mars lander vehicles.

Technology Areas

Primary Technology Area:
Entry, Descent, and Landing Systems (TA 9)
- Aeroassist and Atmospheric Entry (TA 9.1)
  - Deployable Hypersonic Decelerators (TA 9.1.4)
    - Advanced Guidance and Navigation Systems (TA 9.1.4.6)

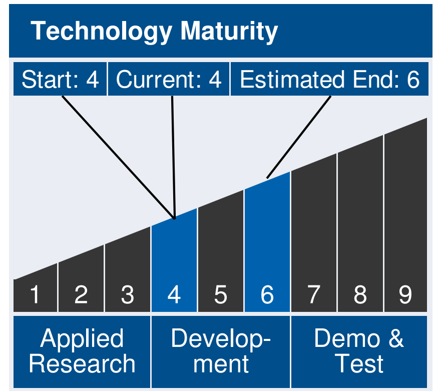
Secondary Technology Area:
Entry, Descent, and Landing Systems (TA 9)
- Descent and Targeting (TA 9.2)

Continued on following page.

Technology Areas *(cont.)*

Additional Technology Areas:

Entry, Descent, and Landing Systems (TA 9)
- Descent and Targeting (TA 9.2)
  - Supersonic Retropropulsion (TA 9.2.3)
    - Advanced Algorithms and Sensors for Supersonic Retropropulsion (SRP) (TA 9.2.3.1)
  - Terrain-Relative Sensing and Characterization (TA 9.2.7)
    - Advanced Sensors for Spacecraft Velocimetry and Altimetry (TA 9.2.7.1)
  - Autonomous Targeting (TA 9.2.8)
    - Terrain/Map Absolute Localization (TA 9.2.8.1)
    - Terrain/Terrain Relative Location (TA 9.2.8.2)
    - Autonomous Hazard Detection and Avoidance (TA 9.2.8.4)



DETAILS FOR TECHNOLOGY 2

Technology Title

LOX/CH4 Engine

Technology Description

This technology is categorized as a hardware component or part for manned spaceflight

Hotfire testing is being performed of a MSFC-developed 4500-lbf thrust regeneratively cooled LOX/CH_4 engine with additively-manufactured injector and thrust chamber. Testing of the 4500-lbf thruster will demonstrate methane-based regenerative cooling, verify performance, and anchor thermal models. The design can be scaled and fabricated for higher thrust levels (e.g. 100 kN / 22 klbf class engine).

Capabilities Provided

High performance in-space engine with potential to be supported by propellants produced in situ from space resources.

Potential Applications

Human and robotic in-space and Mars or Moon ascent and descent vehicles.

Technology Areas

Secondary Technology Area:
In-Space Propulsion Technologies (TA 2)

Additional Technology Areas:
Entry, Descent, and Landing Systems (TA 9)